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HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII

Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION

1925

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HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture]

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REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1925

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SUMMARY OF INVESTIGATIONS

By J. M. Westgate, *Director*

The station continued to investigate the various problems affecting the production, marketing, and utilization of food and forage crops, and to formulate plans for developing such agricultural industries as can be promptly launched in case of some calamity threatening the few leading industries of the islands. The need of promoting greater agricultural diversification is becoming increasingly apparent. Continuous culture of one staple crop on a given area usually results in more rapid soil depletion and development of insect pests and fungus diseases than when an intelligent rotation of crops is practiced. Development of the culture of diversified crops and associated industries is especially important in Hawaii, where people of numerous nationalities and racial mixtures are making their homes. Not all of such a population are content to do the work provided by the comparatively few major local industries. A diversified agricultural program will make possible not only the more even distribution of labor throughout the year by opening new fields of specialized employment, but also the more complete utilization of many lands which are not adapted to the leading crops, thus rendering them contributory to the general economic prosperity of the islands.

The Pan-Pacific Conservation Congress, which met in Honolulu under the auspices of the Pan-Pacific Union from July 31 to August 14, 1924, emphasized the wisdom of following the policies advocated by the station in developing and promoting the diversified agricultural industries of the islands. E. W. Allen, chief of the Office of Experiment Stations, United States Department of Agriculture, a delegate to the congress, made a thorough inspection of the work of the station and gave careful consideration to its various problems.

Some changes in the station boundaries were made during the year. An area aggregating 83,588 square feet (approximately 1.92 acres) near Magazine Street, Honolulu, was transferred to the Territory by order of the President dated December 22, 1924; and two tracts of land, aggregating 0.784 acre, on the slopes of Tantalus, near Honolulu, and originally a part of the station reservation, were transferred to the Territory by order of the President dated January 13, 1925. Through an executive order of the governor dated June 15, 1925, the station received from the Territory a tract of land totaling 0.636 acre on Tantalus, together with the buildings thereon, in connection with a boundary adjustment agreement negotiated in July, 1924. The station also obtained from the commissioner of public lands, Hawaii, authority to use the land occupied by the Haleakala demonstration farm, Maui.

The development of vegetative methods of propagation, which are not only very successful but also so simple as to be readily used by nurserymen, is one of the outstanding achievements of the horticultural division. Commercial orchard development depends for success upon vegetative methods of propagation, since many of the tropical fruits fail to come true to seed. A total of 62 accessions of new and rare economic plants was made during the year to test their adaptability to Hawaiian conditions, and approximately 30,000 plants, young trees, and packages of station-grown seed of improved varieties were distributed to growers in all parts of the Territory and elsewhere. The horticulturist acted as one of the judges in the school-garden contests, making four trips to each of 38 gardens for the purpose.

The work of the agronomy division was directed principally to solving problems dealing with food and forage crops and poultry management, and to cooperation with the extension division in the boys' and girls' club work. In October the agronomist acted as associate poultry judge at the Maui County Agricultural Fair, and as secretary of the poultry show at the Territorial fair, held at Honolulu October 20 to 25, inclusive. The agronomy division had exhibits at both fairs. Accompanied by the executive secretary of the Hawaiian Homes Commission, the agronomist inspected the Molokai homestead lands, which are being opened to native Hawaiians and are thought to have great diversified agricultural possibilities. He also cooperated with the Hawaiian Homes Commission in furnishing improved planting material and crops to homesteaders.

The chemical division confined its efforts principally to solving technical problems arising in connection with the edible canna starch industry, and the preservation of Hawaiian fruits and fruit products. Cooperative work with local manufacturers of preserved fruits was continued, and analyses were made of a large number of varieties of locally grown vegetables, including many of oriental origin.

The extension agent for the island of Hawaii, in addition to his other duties, assisted farmers in working out rational cropping systems, and obtaining improved varieties of plants and seed, and aided in marketing their crops. He also distributed trees for windbreaks, as well as seeds and bulletins; loaned newspaper articles dealing with agricultural topics to various homesteaders; gave advice concerning cultural and fertilizer requirements for the most profitable production of crops; devoted considerable time to boy scout activities; acted as leader in the boys' and girls' club work and as chairman of the agricultural section of the county school fair; and visited as regularly as possible farmers in the different parts of the island. He traveled approximately 11,000 miles, visiting when possible each section once a month, and readily accessible localities more frequently. He also acted as middleman between homesteaders and various sources of agricultural information desired by them.

The superintendent of the Haleakala demonstration farm devoted a small part of his time to county agent activities, and the rest to work on the farm. The Haleakala demonstration farm serves as the distributing center for propagating material of improved food and forage crops, and is conducted to determine and demonstrate what kind of crops can be produced on and the cultural practices best adapted to that part of the island in which the farm is located. Approximately 2,000 feet of new fencing was built at the farm, and about 100 feet of water pipe was changed to permit cultivating what would otherwise be waste ground. The original buildings were made more nearly rainproof than formerly, and a chicken house 7 by 14 feet was erected. The guava, lantana, and pamakani (*Eupatorium glandulosum*) were cleared from the gulch on the north side of the farm to permit use of the ground for pasture.

Boys' and girls' 4–H clubs were organized and conducted on the islands of Oahu, Maui, Hawaii, and Kauai, and new enrollments and some reenrollments were made in the communities doing club work last year, and also in Schofield, Oahu; Lahaina, Maui; and Kapaa, Kauai. Eight new communities were formed on the island of Hawaii. In addition to supervising 38 clubs in Oahu, with an enrollment of over 700 members, the club leader made three visits to Maui and two to Hawaii during the year. About 70 per cent of her time was given to field work, making personal visits to club members, attending club meetings, and promoting club interests, and the rest was devoted to office and demonstration work at the station. The club enrollment in Hawaii was more than double that of last year. A total of 1,460 children enrolled, with 1,095 members, or 75 per cent, reporting.

REPORT OF THE HORTICULTURAL DIVISION

By W. T. Pope

VEGETATIVE PROPAGATION EXPERIMENTS WITH TROPICAL FRUITS

Failure to learn how to propagate fruit trees successfully by vegetative methods is probably one of the greatest hindrances to a more rapid development of the fruit industry in Hawaii. It is estimated that local nurserymen or growers bring an average of less than 15 per cent of their good standard varieties of tropical fruit trees to the proper size and condition for marketing to prospective growers. As a result they are compelled to ask a much higher price for the trees than would be obtained were a larger number of the grafts successful. With budded avocados and grafted mangoes selling at $4.50 each, 2-year-old breadfruit trees at $6, and air-layered litchi trees of a good variety at $25 each, very few are going into the business of fruit growing. Asexual methods of propagating some of the more important tropical fruits worked out by the station are giving very gratifying results.

AVOCADOS

In July and August, 1924, some 1,300 avocado seedlings were grown in gallon tin containers to furnish necessary rootstock material for budding and grafting experiments. The methods used included whip grafting, side-tongue grafting, and shield budding. Of the three the whip-graft method, utilizing very young growth, proved to be the most satisfactory. (Fig. 1.) The stock and scion materials are more readily obtained for this method than for the others, and the trees can be set in their permanent places before the roots become pot-bound. Trees of proper size for setting out can be produced in six months after the seed has been planted, or five to nine months earlier than under the old methods. A better union is obtained and a larger number of successes result when early growth is used. Over 60 per cent of successful grafts have been made with the Macdonald variety of avocado.

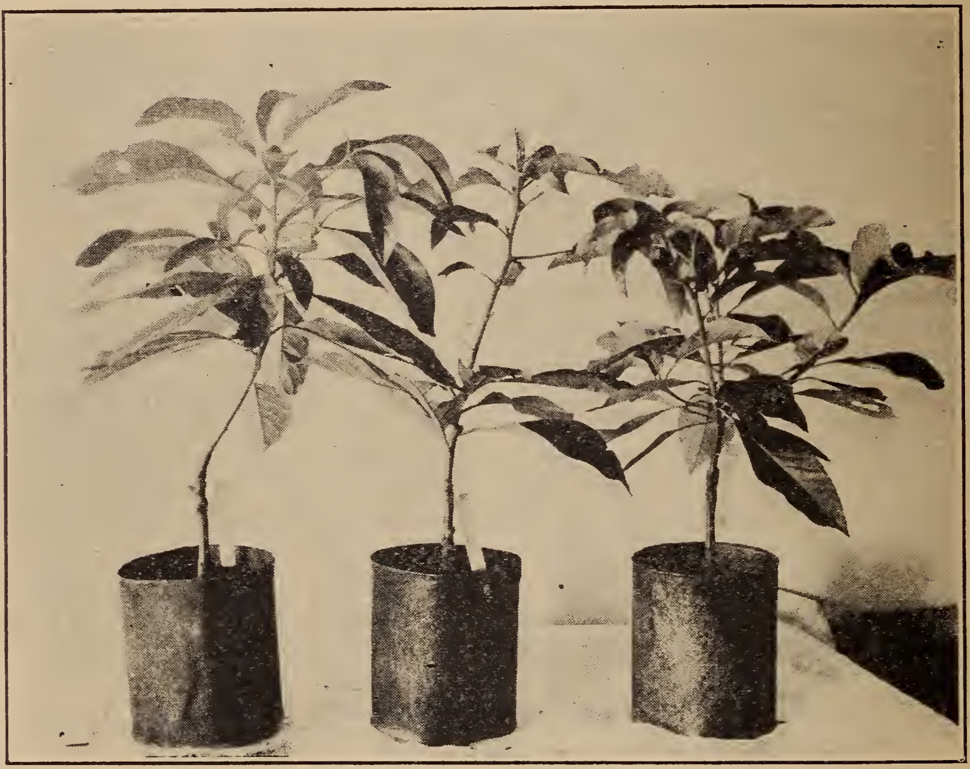

FIG 1.—Whip-grafted avocado trees ready for setting out, 146 days after germination of seed for stock

The side-tongue method of propagating avocado trees is adapted to seedling stocks over 6 months old. The scion and the stock should have reached the same stage of maturity, and even then may fail to unite perfectly. The side-tongue method, notwithstanding its disadvantage, has been found to be superior to shield budding, the heretofore most commonly practiced method of propagating avocados. Shield budding is at best a very slow method of propagation, especially when the seedlings are grown in tin and other containers, as must be done in most parts of Hawaii. Bud wood is rather hard to find during the "flushing" period of the seedlings. Budded trees are often difficult to straighten properly before they are set out, and usually are difficult to sell. However, they usually straighten of their own accord during the first years of growth.

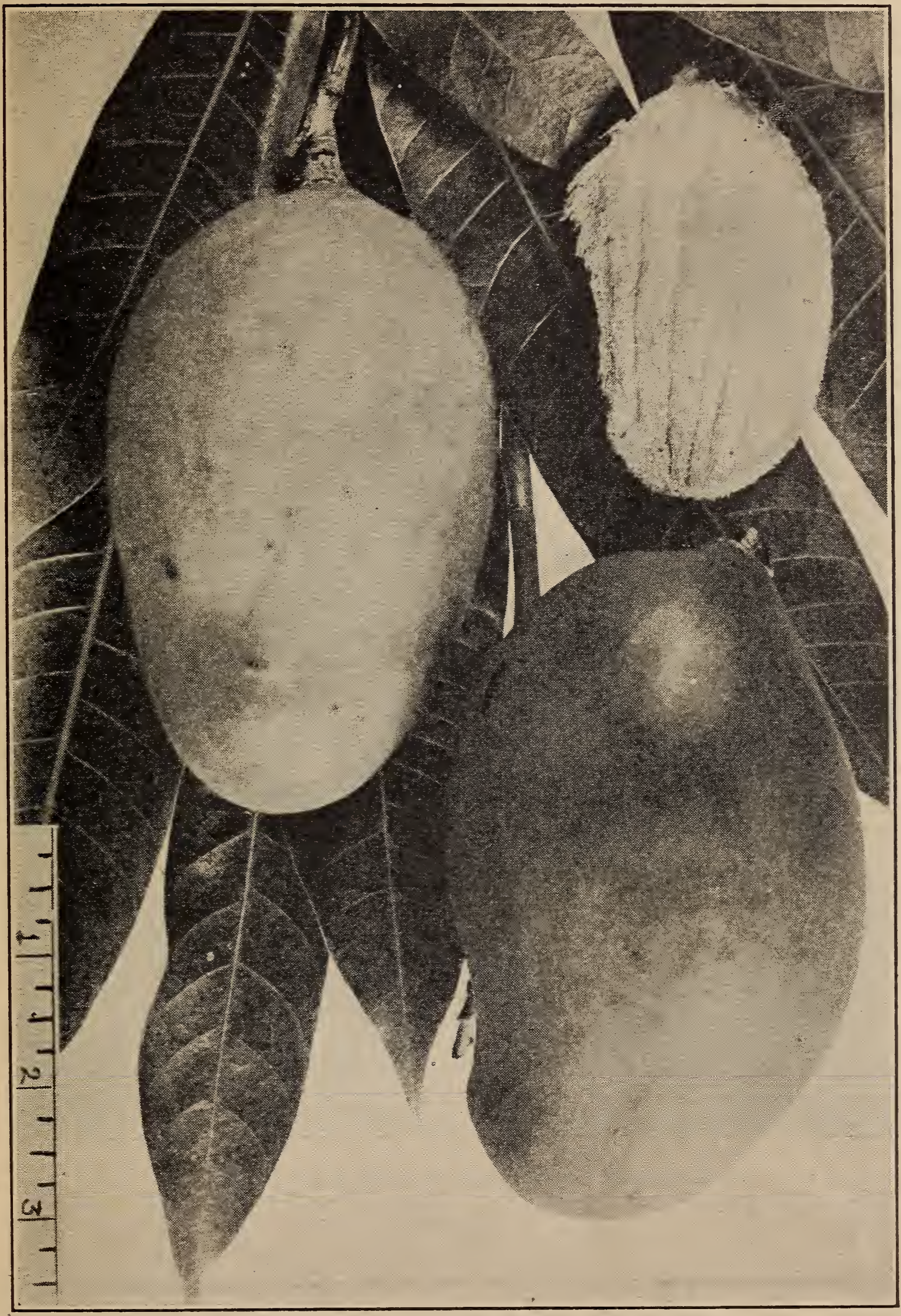

FIG. 2.—The Victoria, one of the best mangoes for general culture in Hawaii. The skin is a brilliant red and resistant to the fruit fly

MANGOES

The side-tongue method of grafting, as previously worked out at the station, was repeated with a number of selected varieties of the mango, including the Victoria, Pirie, Mulgoba, Alphonse, Whitney, Wootten, and Kalihi. The Victoria, a vigorous and prolific yielder of excellent fruit, is a general favorite among growers (fig. 2), and is not subject to attack by the Mediterranean fruit fly. Seedlings of the sturdy Hawaiian mango were grown from seed in gallon containers and kept growing vigorously for 8 to 12 months, when they are of suitable size for grafting. (Fig. 3.) The satisfactory results obtained again confirm the value of the side-tongue method of grafting for mangoes under Hawaiian conditions.

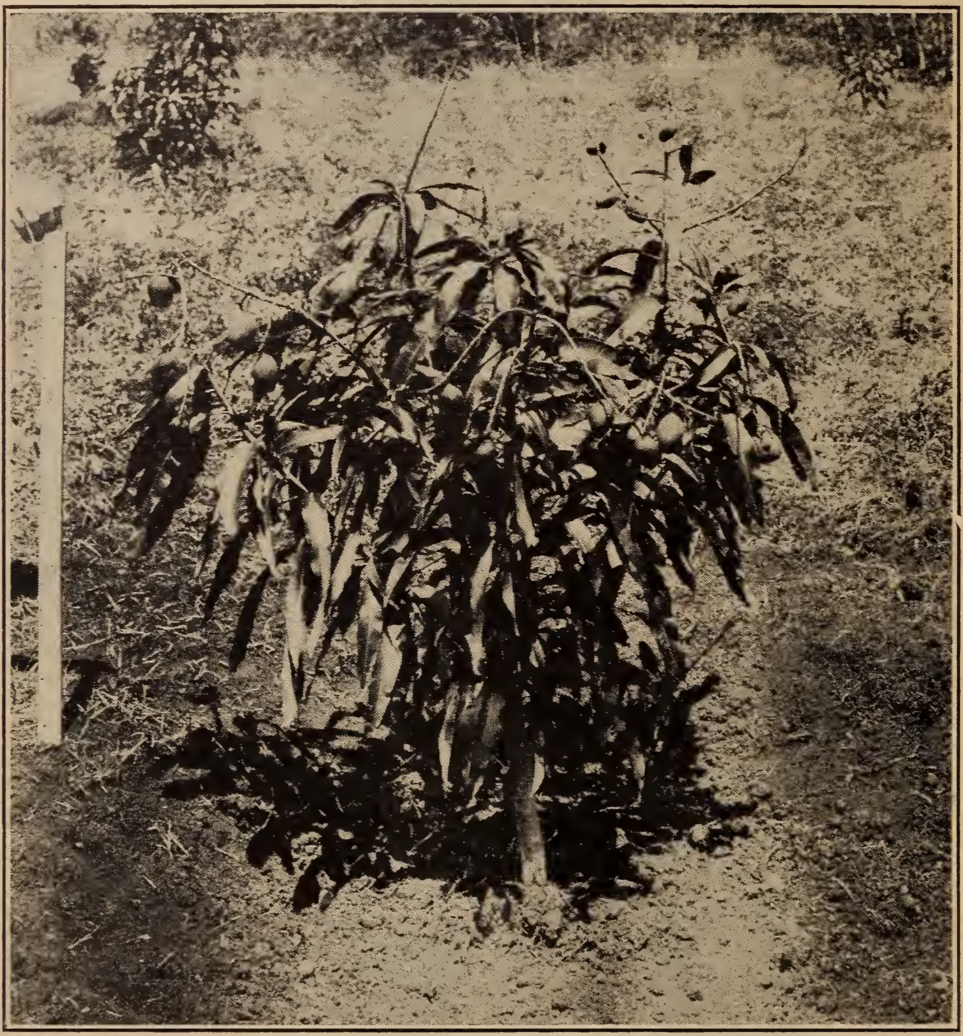

FIG. 3.—Grafted Victoria mango tree 2 years of age, with 42 fruits

GRAPES

Promising varieties of grapes were received from various local growers during the year, and a number of new varieties were propagated from cuttings received from California. Of 16 varieties which were successfully grafted on 3-year-old Isabella rootstocks in January, 1925, Lisbon, Jakea, and Campo Alegre came into fruit in June, 1925. Scions of the Scuppernong and another variety of the Muscadine type failed to unite with the Isabella variety. Root cuttings of Isabella grapes growing in gallon containers were successfully grafted with a number of different varieties, and plants grown from seed introduced from southern Georgia are making excellent growth.

BREADFRUIT

Methods of propagating seedless breadfruit trees from surface roots have been under test at the station since 1921. Each year the tests yield additional information, which is making possible the production of a greater quantity of propagating material. The rooting and sprouting of cuttings is a slow process, and even after the young trees are a foot high they may fail to survive transplanting from the propagating bed. It has been found advisable to maintain them in the propagating bench until they are considerably more than a foot high. This is done by underlaying the 6-inch layer of coral sand in the propagating bed with a 4-inch layer of rich, loose soil. The soil contains a greater amount of available plant food and will stimulate root growth and prevent the stunting which usually occurs when the cuttings are grown in coral sand alone. If the young trees are potted off in soil some time before transplanting, the roots will become sufficiently well established to withstand open-ground conditions. A number of root cuttings of different varieties, obtained from the Society Islands, south Pacific Ocean, are being propagated in the same manner as the Hawaiian variety.

The breadfruit tree is highly ornamental and should be grown in every garden. A single tree will often produce sufficient fruit for the average family during six or eight months of the year. Heavy demands were made upon the station for the trees, but distribution of surplus material was confined to experimenters working in cooperation with the station.

LITCHI

Several of the litchi trees in the station orchard have reached sufficient size for air layering. In October, 1924, some 14 branches, each 4 or 5 feet long, in the tops of litchi trees were scarred where it was desired to have roots start. On the following day the wounds were surrounded with masses of soil held firmly in place by wide burlap bands and galvanized poultry wire. A gallon container filled with water and having an opening in the bottom to permit a slow drip was suspended above each mass to keep it moist. After five months the branches had established root systems and were severed from the trees and set in tubs filled with soil. (Fig. 4.) This method, although not entirely new in Hawaii, is proving very successful as a means of rapidly propagating the litchi. Air layering has long been employed in China and undoubtedly is far superior to inarching, grafting, or budding, none of which has been successful at the station.

SEED PROPAGATION OF TROPICAL FRUITS

It is necessary to rely on seedlings in much of the propagating work. The advisibility of using only selected seed has been strongly confirmed in the work of the station. Good seed is especially important in the improvement of annual plants, such as the tomato and the roselle. The work on the production of perennial stock plants on which to bud or graft choice varieties of fruit, such as the mango, avocado, or citrus, indicates that selected seeds of certain varieties or species produce more vigorous trees and give better unions than do those of other varieties. Rootstocks from the seed of the sturdy Hawaiian mangoes, for instance, are often superior to seedlings grown from the seed of improved imported varieties. Both oranges and lemons may be grafted into many species of citrus stock, but they are found to be more vigorous and productive when united to certain species, as, for example, the sour orange in preference to the rough lemon.

HYBRIDIZATION EXPERIMENTS

Cross-pollination experiments were made during the year in connection with tomato and papaya breeding. Several hundred tomato crosses were made, and seedlings from the more desirable types have already been obtained. Crosses were also made between papayas of different types to determine to what extent the fruit of the tree of one type may be influenced directly by pollen from a tree of a different type.

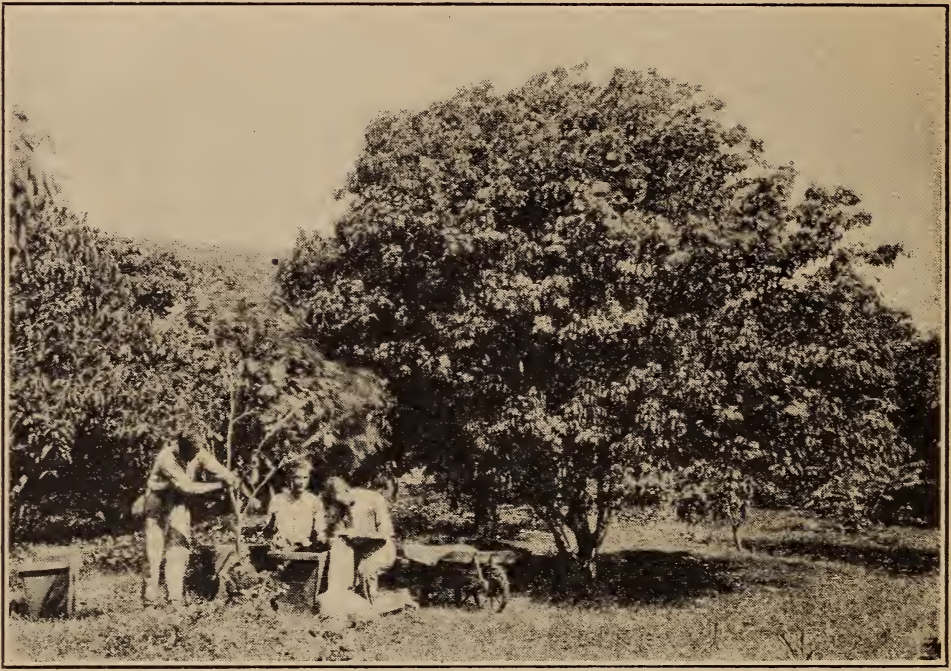

FIG. 4.—Setting air-layered branches of litchi tree in tubs for further root development before planting in the orchard

MISCELLANEOUS INTRODUCTIONS

Among the introductions of the year were 25 specimens of Pejibaye palms (*Guilielma utilis*) from Central America, received through the Office of Foreign Seed and Plant Introduction, United States Department of Agriculture, plants of yerba maté (*Ilex paraguayensis*), root cuttings of 18 varieties of breadfruit from the South Seas, as well as propagating material of 8 varieties of grapes. Seed of the jaboticaba (*Myrciaria* sp.) from Pernambuco was received, but it did not arrive in a viable condition. A number of other plants received from local cooperators and not under test for several years included 3 varieties of annonas, 2 of the cashew nut, 4 of bananas, and several varieties of mangoes, avocados, citrus, and granadilla. The Pejibaye palms are doing so well as to indicate the establishment in Hawaii of this valuable species, the fruit of which is edible. Vigorous plants of durian (*Durio zibethinus*) and rambutan (*Nephelium lappaceum*) have developed from seeds received from the botanical gardens of Buitenzorg, Java. A single tree of the durian, an early introduction, has fruited in Hawaii, but the fruit is not generally known locally. The rambutan is of Malayan origin and is very extensively used elsewhere in the Tropics, but is new to these islands.

HORTICULTURAL EXTENSION WORK

Not infrequently the horticultural division is visited by students and others who are interested in some branch of its work. Every effort is made to stimulate interest in work of a horticultural nature, and demonstrations are given so that the visitors may learn the proper methods. In many instances the students are given the opportunity to put into actual practice the instructions given. A number of exhibits were made at fairs and other gatherings where illustrative material was used to disseminate agricultural information. On these occasions the horticulturist emphasized the need of using station and Department of Agriculture publications dealing with improved methods of culture and pest control.

DISTRIBUTION OF SEEDS AND PLANTS

Approximately 30,000 plants and packages of improved station-grown seed were distributed during the year to growers in different parts of the Territory, and to some on the mainland and elsewhere. Seed and plant distribution as practiced by the station serves as a stimulus to a more rapid development of Hawaiian horticulture. It creates a greater demand for plants and causes them to be grown by people who would hardly do so were a cash outlay involved. It also brings to the attention of many people the important work in plant improvement which the station has under way, and gives the station the benefit of numerous cooperative experiments over a wide range of conditions.

REPORT OF THE AGRONOMY DIVISION

By H. L. Chung

CORN

The new variety of sweet corn which the station originated by crossing the Henderson sweet with a white Guam corn, has well-fixed characters and combines the color and wrinkled kernels of the former with the stalkiness and leaf-hopper resistance of the latter. A large quantity of the seed of this new variety was distributed.

Golden Bantam, another sweet variety, is proving popular, but has the disadvantage that it it can not be grown in localities where the corn leaf hopper is present in abundance. Work was undertaken to develop a variety proving resistant to leaf-hopper attack and having a sturdy stalk. A yellow strain of Guam corn resulting from a cross between Guam corn and Cuban Red was pollinated with Golden Bantam for this purpose. Seeds obtained from the cross will be used for further work.

TARO

Taro problems are becoming increasingly important as the natural habitat of the crop is being used for other purposes. Land values near the city of Honolulu, Oahu, have increased considerably, and the rentals asked for taro areas in the vicinity have correspondingly increased. As a result many of the taro-growing lands are no longer used for that purpose. Ordinarily these abandoned areas are sold for home sites. Realizing that under these circumstances dry-land taro is likely to play an important rôle in the agriculture of the islands, the agronomist obtained from Thomas White, of Kona, Hawaii, a large collection of promising dry-land varieties to determine their relative physical characteristics, drought-resistant ability, and adaptability to various types of soil. A collection of both wet and dry-land taro tops was also received from American Samoa through the courtesy of E. M. Ehrhorn, chief plant inspector of the Territorial Board of Agriculture and Forestry, Honolulu. The taro tops are reported to be from varieties of the Mammoth type. The wet-land varieties are being tested in a specially prepared aquatic area in the agronomy field.

EDIBLE CANNA

Edible canna investigations were confined to cultural tests made to learn the effect of green manuring and close planting on the yield of tubers.

SWEET POTATOES

The large collection of sweet-potato hybrids resulting from crosses made in 1924 was considerably reduced in number. Many of the seedlings showed undesirable features and were eliminated at harvest time, and others were discarded because they failed to prove superior to the standard varieties when cooked.

Approximately 60,000 sweet-potato cuttings of improved varieties were distributed during the year. A large number of the cuttings were sent to homesteaders on Molokai.

WHITE POTATOES

A potato variety of the Hamakua strain is proving well adapted to the lowlands of the islands. In addition to being a good producer, it is a much better keeper than the original Hamakua variety and has tender skin and very conspicuous lavender-colored eyes. Stock for further tests and distribution is on hand for next season's planting.

LETTUCE

The erroneous local belief that head lettuce can not be successfully grown in Hawaii has resulted in importation of large quantities of lettuce from California. Lettuce can be found throughout the year in many of the Japanese vegetable stalls, to which it is brought by Japanese truck gardeners from Waimea, Hawaii, and other cool regions of the islands. A series of variety tests with head lettuce was made during the year, and 6 of the 15 varieties originally tested were retained. However, the varieties and individual plants selected varied considerably in degree of solidity of the heads. The best individual plants were retained for further breeding work.

FORAGE GRASSES

Approximately 50,000 cuttings of Napier grass (*Pennisetum purpureum*) and Merker grass (*P. merkeri*) were distributed during the year. Both grasses are in great favor with poultrymen, cattlemen, and draft-horse owners. Merker grass has undergone a great change through careful selection. Of the two distinct types established, one has very thin stalks and is suitable for green feed for poultry, whereas the other has thick and rank-growing stems and is adapted to cattle and horse feeding.

A demonstration area devoted to different species of grass is maintained in one of the agronomy fields, and the yield is noted at each harvest. Guatemala grass (*Tripsacum laxum*) has so far proved to be well adapted to areas of limited rainfall. Each season the plants produce fertile seeds, which are distributed to Hawaiian ranchers for test. Tunis, Sudan, and Wonder Forage grasses, found to be affected with the mosaic disease, are being studied by the pathology division of the Hawaiian Sugar Planters' station with reference to transmission of the mosaic to seedlings from seeds of diseased plants.

DISTRIBUTION OF SEEDS AND CUTTINGS

A large quantity of seeds and cuttings was distributed. Cuttings of various kinds of grasses formed the bulk of the distribution for forage purposes, and sweet potatoes, corn, lettuce, and edible canna were most largely distributed for human consumption.

Many of the experts who attended the Pan-Pacific Conservation Congress from July 31 to August 14, 1924, were supplied upon request with seeds and cuttings of the more promising economic plants, especially those adapted for green-manure purposes.

POULTRY INVESTIGATIONS

Sorehead and roup of poultry, which have been prevalent throughout the islands, continued to receive attention. Other poultry troubles reported to the agronomist included bumblefoot, atrophy of the liver, canker, and intestinal worms.

REPORT OF THE CHEMICAL DIVISION

By J. C. Ripperton

EDIBLE CANNA INVESTIGATIONS

During the year the chemist visited a number of cornstarch manufacturing concerns on the mainland to learn to what extent their methods might be applicable to edible canna starch making in Hawaii. Manufacturers of standard types of washers, shredders, extractors, purifiers, and driers were also consulted as to the possible adaptability of their machines to the product. A series of samples of canna starch prepared from factory runs on a large scale, using different procedures in the manufacturing process, was submitted to a number of textile plant directors, dextrin manufacturers, starch brokers, and the like for the purpose of obtaining information on the manufacturing process and to determine to what general uses edible canna starch might be adapted.

METHODS OF STUDY

Every effort was made to devise methods admitting of continuous study of the growth of edible canna on the various experimental plats both at the central station and at Waimea, Hawaii. Some of the more important features of the work include (1) classification of tubers, the lot from each hill being grouped as dormant, mature, immature with stalk developing, or immature with undeveloped stalk, depending upon the appearance of the stalk; (2) genealogy of tubers, which are divided according to successive generations, beginning with the original tuber; (3) determination of the reducing and nonreducing sugars in the expressed sap of the tubers and stalk; and (4) determination of the specific gravity of the tubers.

METHOD OF GROWTH

A study was made of the lateral, longitudinal, and apical growth of individual tubers as well as of the deposition of starch in the storage cells after growth of the tuber had ceased. The fact that a very large part of the growth of any tuber comes from the parent plant and not from its own stalk emphasizes the importance of the early stalk growth of the hill upon subsequent storage of starch. The common observation that a hill of canna gradually "runs out," the new growth producing tubers decreasing in size until they ultimately become undesirable for starch making, has led to a study to learn whether this phenomenon is due to physiological influence or such external influences as soil packing and lack of aeration.

FIELD EXPERIMENTS

Edible canna was grown on a field scale at the station, and classifications of hills were made each month, beginning with the twelfth month after planting and extending through the twenty-second month. Studies were made of the effect of planting at different depths on manner of growth, and of varying the quantities of irrigation water on the growing crop. A total of 15 acres is now under cultivation at Waimea, Hawaii, in cooperation with a private starch-manufacturing concern and the extension agent on Hawaii. (Fig. 5.) Homesteaders are showing considerable interest in the experiment, which includes the best time of applying fertilizers to canna, tuber selection for planting, the effect of spacing and depth of planting on yield of tubers, and the feasibility of mulching with canna tops. Monthly harvests from 9-month-old crops were begun on 2 one-tenth acre plats to be carried through to the eighteenth month from planting to learn the best age at which to harvest the crop. Another experiment was begun on 42 one-tenth acre plats to determine the fertilizer formula best suited to the crop.

VARIATION IN CHEMICAL COMPOSITION

As has been previously noted,[1] the chemical composition of individual tubers within a single hill is subject to wide variation, due primarily to the continuous growth of the hill, the tubers within it varying in age from developing buds to full-grown dormant tubers.

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[1] Hawaii Sta. Bul. 54, p. 8; Edible canna in Hawaii.

Further studies were made of these variations correlated with the above-outlined investigations of the methods of studying the growth of the plant.

The nature of the sugar formed by photosynthesis in the leaves was determined, as well as the changes occurring during translocation of the sugar through the sheaths and stalks to its storage in the tubers as starch. The determination of the sugars in connection with the classification and genealogy of the hill as a means of estimating the rate of growth of the plant is a promising method. Sap samples from

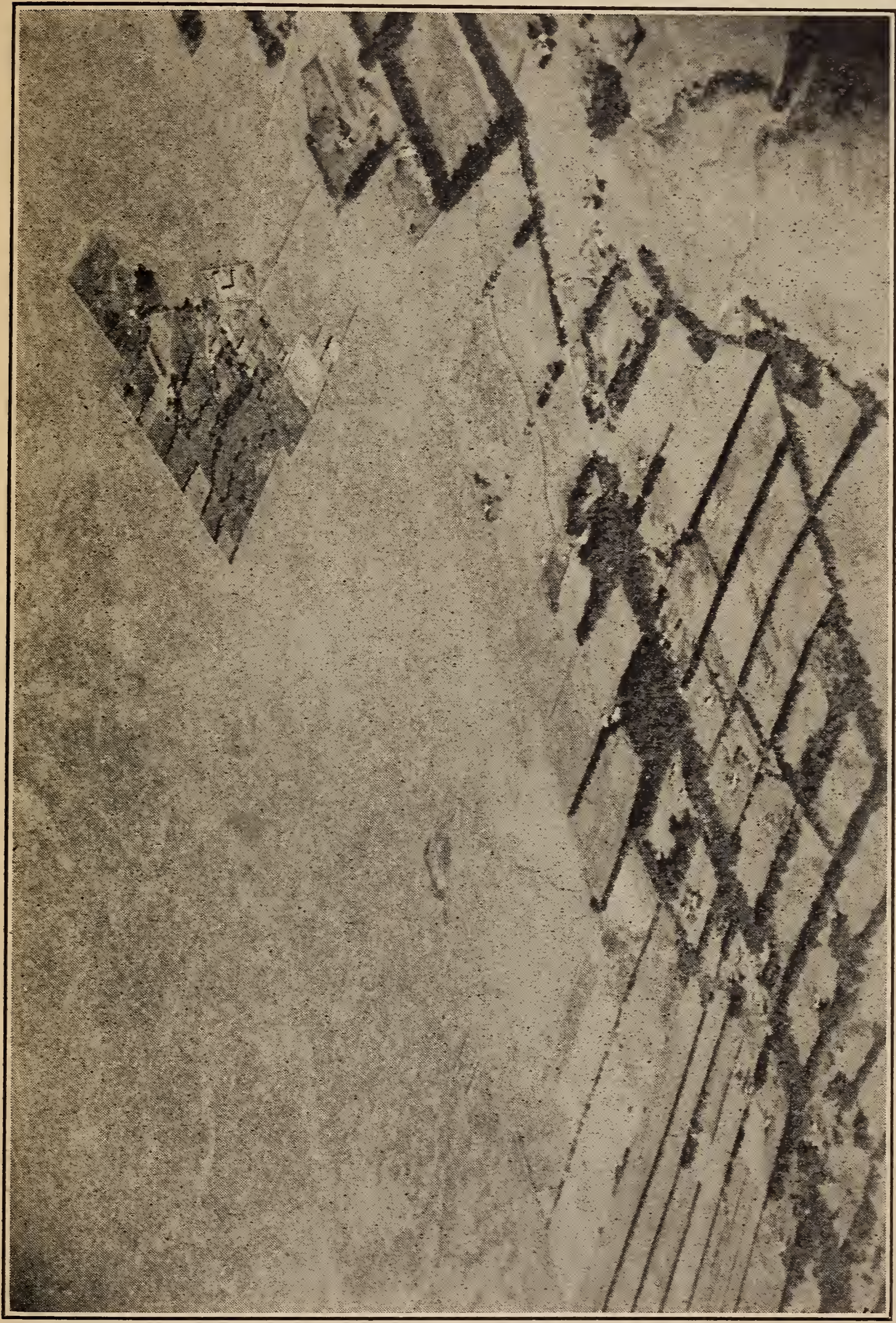

Fig. 5.—Aerial view of the Waimea homesteads where edible canna is now being grown for its starch. In the foreground is grazing land which ultimately will be available for canna production. The climate and soil of this district make it ideally adapted to this crop. Note the general use of windbreaks. (Courtesy of the eleventh photo section, Luke Field, U. S. Army, Hawaiian Division)

plants in the various experimental plats were collected at intervals for analysis, and other components of the plant sap were also investigated. Of special importance with reference to the manufacture of starch is the slimy precipitate, which settles out and intermixes with the upper stratum of starch and renders purification and sedimentation difficult when the process is delayed. Studies were made of the nature and causes of the precipitate, and the methods devised for preventing it are being tested in connection with the commercial purification of the starch.

Microscopic studies were made of the morphological characteristics of the starch in the stalk and in the different parts of the tuber. The granules were found to vary considerably in size, depending upon their location in the plant. This fact would seem to be of importance from the commercial standpoint. Determination was also made of the starch in the leaves, sheaths, and stems in connection with the carbohydrate metabolism of the stalk. The percentages of actual starch in the tubers of different ages, classes, and generations were determined by the diastase method. These determinations, coupled with the specific gravity determinations, should make possible the construction of a table enabling the chemist to estimate quickly the approximate starch content of a lot of tubers in the field or factory.

Determinations of the principal ash constituents of the canna plant were begun to learn its mineral requirements at different stages of growth.

POSSIBLE USES OF THE STARCH

Samples of edible canna starch were submitted to a number of industrial starch users who are interested in the product. The starch seems to have potential possibilities for commercial purposes, if it can be produced at a price sufficiently low to permit its competing successfully on the market with potato, cassava, and sago starches. Because of the lack of standard laboratory methods of evaluating a starch or accurately determining its properties, it will hardly be possible to learn to what extent edible canna starch can be used until factory runs on a large scale are made in the various industries. Samples of commercial starches were procured from the mainland to compare their merits with those of the edible canna starch. The comparisons should show the general nature of the uses to which edible canna starch may ultimately be put.

PRESERVATION OF HAWAIIAN FRUITS

A special study was made of the kinds of machinery and methods used by various fruit-preserving concerns on the mainland, and samples of jellies, jams, and conserves from locally grown fruit were submitted to wholesale dealers for suggestions as to their salability and improvement. The poha, guava, and pineapple jams and marmalades were received with special interest by the mainland concerns. Efforts are under way to develop a profitable mainland market for these fruit products. Cooperative work with a local company was continued, the chemical division rendering general assistance in testing fruit juices, standardizing fruit products, and emphasizing the need of employing up-to-date methods and machinery in the manufacture of fruit products. (Figs. 6 and 7.)

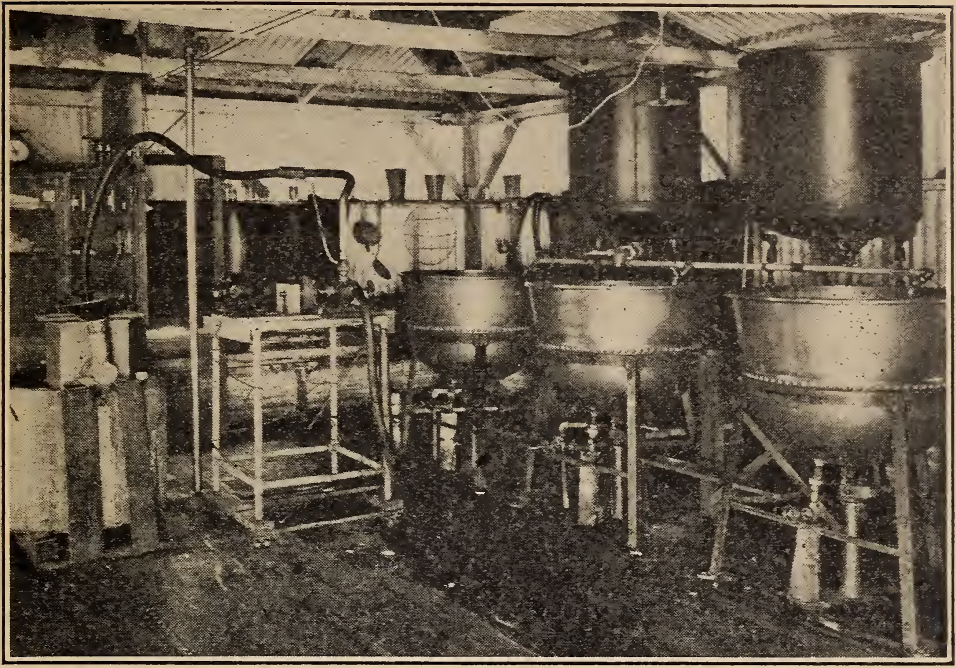

FIG. 6.—Interior of a modern fruit-preserving plant in Hawaii, showing the large steam-jacketed copper boiling kettles and above them the glass-lined storage tanks

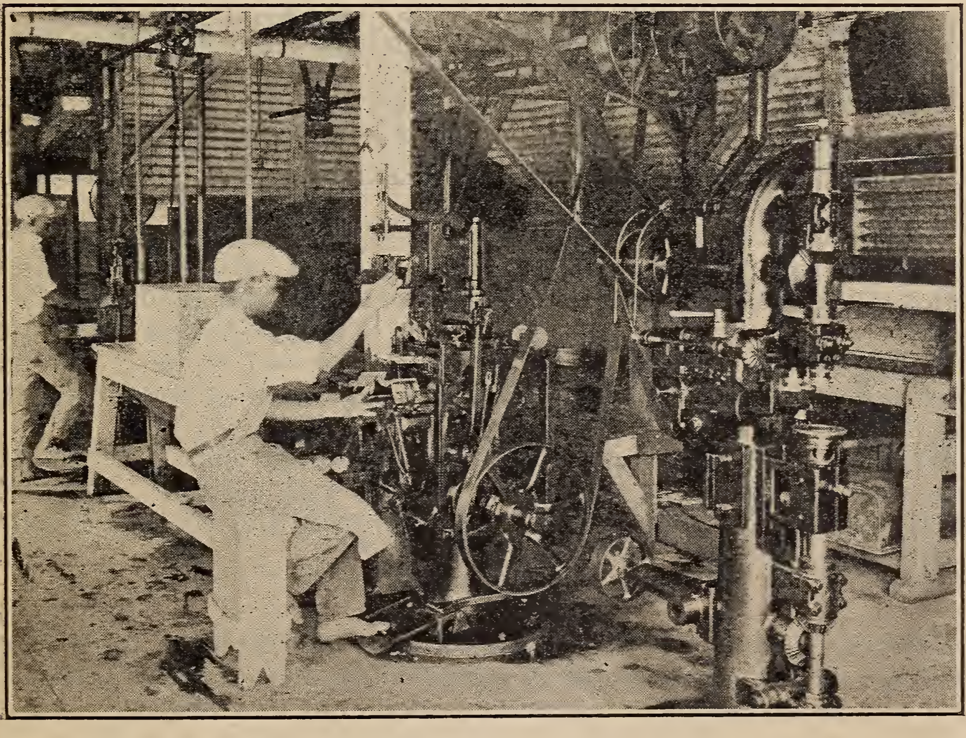

FIG. 7.—Modern machinery used in filling, capping, and labeling

COMPOSITION OF HAWAIIAN-GROWN VEGETABLES

Completion of the tri-local vegetable experiment undertaken to compare the mineral constituents of Hawaiian and mainland grown vegetables was postponed because of crop failures in one of the localities under test. Analyses were begun of a series of 45 different Hawaiian-grown vegetables collected by the agronomist of the station, and will include determinations of their nutritive constituents as well as of calcium, phosphorus, iron, and alkalinity of ash.

HALEAKALA SUBSTATION AND DEMONSTRATION FARM

By H. F. Willey

FORAGE CROPS

Pigeon peas.—About 6 acres were planted with pigeon peas at the Haleakala substation and demonstration farm in September, 1924. Merker and Napier grasses were planted between the rows of pigeon peas in half the field, and various smaller tame grasses between the rows of the other half. The area is later to be used as a pasture for milch cows. A 2-acre field on which tame grasses were interplanted with pigeon peas was used as a hog pasture. The grasses made excellent pasture, but many of the pigeon peas were wasted in the efforts of the larger animals to get at the pods. Pigeon peas are also being grown on a half-acre plat for the production of seed for distribution to interested farmers. It is impossible at times to supply the demand for pigeon-pea seed. On account of the peculiar climatic conditions prevailing in this region the crop produces seed under difficulty, many of the pods becoming moldy before drying sufficiently to shell.

Purple vetch.—Purple vetch, planted in September, 1924, is in excellent condition and makes one of the best cover crops available. The crop has proved its efficiency as a weed destroyer at a mountain summer home at an elevation of 3,500 feet.

Cultivated grasses.—Of eight varieties of grasses planted during the year, Harding, orchard, perennial rye, Rhodes, and Smilo grasses withstood adverse weather conditions very well and made excellent pasture. Merker and Napier grasses again demonstrated their value as soiling crops, and the Harding variety proved to be one of the most valuable pasture grasses tried, the high cost of seed being its only handicap.

Sorghum.—Ratoon crops of kafir and Egyptian corn, feterita, and milo were harvested at intervals of about two months. After the fourth cutting the crops made stunted growth and the heads failed to fill well.

ROOT CROPS

Cassava.—Twenty hills of Cassava were harvested in early May, yielding on the average about 10 pounds of roots to the hill 10 months after planting. Seventy-five cuttings were planted May 29, 1925.

Edible canna.—Harvested May 8, 12 months after planting, edible canna yielded on the average 10.5 pounds of tubers to the hill. No greater yield was obtained in the school gardens at lower altitudes, from which it is concluded that the high altitude of the demonstration farm does not seriously affect growth. The boarding schools of Maui are using edible canna tubers as a substitute for white potatoes. During May, 1925, about 50 pounds of the tubers were planted.

Taro.—Of 10 varieties of dry-land taro which were harvested in early May, Mana Ulaula, Mana Eleele, Iaia, and Lehua gave good results. Another planting of these varieties was made May 30.

Sweet potatoes.—Twenty varieties of sweet potatoes were planted in small plats, and some of the most prolific varieties in large plats in May. Thousands of cuttings of the leading varieties, including Tantalus, Haleakala, Madeira, Yellow Yam, Delicious Yellow, Native Red, and Huamoa, have been distributed on Maui for use as a stock feed and for human consumption.

White potatoes.—The varieties Red Rose, White Rose, British Queen, and Burbank were harvested November 11, yielding a crop only equal to the quantity of seed planted. After the ground was plowed it yielded a volunteer crop proving better than the original, apparently because of the more favorable weather conditions.

VEGETABLES

Squash.—Approximately 400 fruits of a Vegetable Marrow variety were harvested in November and December, and largely used as a hog feed. Another planting of the same variety made in February failed to produce a crop.

Pumpkin.—About 100 pumpkins of the Jack O'Lantern, Mammoth King, and Boston Pie varieties were harvested in November and December for table use and as a hog feed.

Radishes.—Of four varieties of radish planted in February, White Icicle and French Breakfast made the best growth. Crimson Giant and Long Scarlet Short Top grew slowly, were pithy, and had a biting taste.

Carrots.—The varieties Oxheart, French Forcing, Danvers Half Long, and Long Orange are growing slowly as a result of cool weather.

Peas.—Of the four varieties of peas, Telephone, American Wonder, Stratagem, and Bellingham, planted in February, the last two named were the only ones to succeed. A second planting made in May was in excellent condition by June.

Beans.—Twelve varieties of beans were planted in February, but were killed by the cold, wet weather. The varieties Kentucky Wonder, Davis Kidney Wax, Lazy Wife, Stringless Green Pod, and White Seeded Kentucky Wonder, planted May 14, were in excellent condition by June 30.

Lettuce.—The varieties California Cream Butter, All Seasons, May King, and Immensity, planted in February, were killed by heavy rains. A second planting made May 16 is doing well at this writing (June 30).

Tomatoes.—The Dwarf Stone variety of tomato was harvested during July, August, and September. Fifty plants yielded approximately 20 bushels of smooth, ripe fruits, and 3 bushels of green fruits which were used for pickling and relishes. The New Stone variety bore very heavily, but most of its fruit rotted at the stem end and dropped prematurely from the vine. A few plants of the Haleakala and John Baer varieties, which have already established their reputations at the farm, were grown as a basis of comparison. Ponderosa, Chalk's Early Jewel, John Baer, Haleakala, Dwarf Stone, and New Stone were planted in February, but failed to thrive because of unfavorable weather. Another planting of the same varieties made in May is doing well.

Watermelons.—Watermelons of the Kleckley Sweets variety were planted in February, but were killed by cold rains.

FRUITS

A number of fruit trees were planted in November, including those of the mulberry, star apple, mango, avocado, pomegranate, soursop, fig, and papaya. All are growing except the papaya. Plantings previously made are growing very slowly.

Pineapples.—The second crop of Smooth Cayenne pineapples, planted without paper mulch in October, 1922, was in bloom June 1. The plants have good color and give promise of yielding a fair crop. Pineapples planted in June, 1923, under paper mulch, averaged 3¼ pounds from unfertilized and 3¾ pounds from fertilized plats. Fifty acres on an adjoining ranch are being planted with pineapples, apparently as the result of the showing made by the early plantings at the farm.

Strawberries.—The variety New Carolina has been grown for three years. The crop ripens slowly, but the fruit is large and abundant. The demands for the plants were very heavy. Some of the homesteaders who received plants from the farm last year are now marketing their berries at 50 cents a pound.

MISCELLANEOUS PLANTINGS

Peanuts.—The Cuban and Valencia varieties of peanut were harvested in November. One pound of the Cuban seed yielded 17 pounds of peanuts, and 5 pounds of the Valencia 95 pounds of peanuts. The climate is unfavorable to production on a commercial scale, causing the crop to mold before it can be dried.

Broomcorn.—The varieties A and M Dwarf, Standard Dwarf, California Golden Standard, Acme, and Whisk Dwarf were harvested in July. The second crop was harvested in October, and the third the following January.

Trees for windbreaks.—Of 1,200 eucalyptus trees (*Eucalyptus robusta*) planted in January, only 800 survived the unfavorable weather. Eucalyptus trees planted in 1922 are now between 25 and 30 feet high and are forming an efficient windbreak along the north side of the farm.

Field corn.—Nine varieties of field corn, harvested from 12 acres of land between October 15 and November 15, yielded an average of approximately 25 bushels per acre. The best of the seed was selected for further work, and the rest was fed to the farm stock. The varieties Bloody Butcher, Haleakala, Indian Squaw, Calico, Kula, Red Flint, and Guam were planted in February, most of them being fertilized with bone meal. The early growth of the crop was excellent, but the later growth was seriously affected by the cold rains which set in shortly after planting.

Pop corn.—Both pearl and yellow varieties of pop corn were grown during the year. The pearl is by far the best. It yielded over 100 pounds of shelled corn from 1 pound of seed planted.

DISTRIBUTION OF SEEDS AND CUTTINGS

Propagating material was distributed during the year, as follows:

Table 1.—*Propagating material distributed during the fiscal year ended June 30, 1925, Haleakala demonstration farm*

Crop	Seed	Cuttings	Tubers	Plants
	Pounds	*Number*	*Pounds*	*Number*
Pigeon pea	45			
Beans	10½			
Peas	6¼			
Broomcorn	1½			
Cowpeas	2½			
Pop corn	20¼			
Field corn	157			
Tomato	¼			
Edible canna			1,000	
Strawberry				1,525
Pineapple				175
Sweet potato		6,000		
Napier and Merker grasses		7,000		

LIVESTOCK

The farm keeps a registered Holstein bull and a purebred Duroc-Jersey boar for community service. It also has 4 milk cows, 4 calves, 2 mules, 1 saddle pony, 7 brood sows, 4 pigs, and 100 chickens, for which green feed and part of the grain were raised on the farm.

RIDGING ATTACHMENT FOR USE IN PINEAPPLE FIELDS

An implement designed primarily for ridging up rows in pineapple fields, consisting of a combination of disks attached to a 5-tooth cultivator, was devised. It is already on sale in the local market, and is being used by a number of pineapple growers.

AGRICULTURAL EXTENSION WORK

Considerable time was devoted to the boys' and girls' club work at the local schools. The gardens showed an improvement over those of the previous year, and the pupils manifested considerable interest in the work. It is becoming very evident that the school is the place in which to start agricultural extension work. The Home and School Garden Fair, held at the Kahului fair grounds in May, proved that the youngsters can work. The superintendent acted as one of the judges at the fair and assisted the different schools in selecting their exhibits. He assumed the leadership of the Haleakala boys' and girls' pig club and helped the members in every possible way. Instruction was given in the best methods of feeding and handling the pigs, and grass cuttings were distributed for propagation. The superintendent also acted as a chairman of the committee for the boys' and girls' club at the seventh annual Maui County Agricultural Fair, and not only saw to it that the pigs were delivered at the fair grounds and properly exhibited, but also that the winners received the pigs awarded them as prizes.

REPORT OF EXTENSION AND DEMONSTRATION WORK ON THE ISLAND OF HAWAII

By R. A. Goff

Boys' and girls' clubs.—Boys' and girls' club work, including sewing clubs, canning clubs, pig clubs, poultry clubs, rabbit clubs, and garden clubs, was organized in 12 schools on the island of Hawaii, and a start was made in 6 other schools. Monthly meetings were held, and record books, Farmers' Bulletins of the United States Department of Agriculture, and other pamphlets of agricultural interest were distributed to members. The club in a body visited each home to observe the progress in club work, and many of the members entered exhibits at the country school fair, where ribbons and cash prizes were awarded the winners.

Hawaii school fair.—Vegetables from home and school gardens and field crops from demonstration plats in school gardens were displayed in the agricultural section of the Hawaii school fair held in Hilo May 15 and 16. The livestock section was larger than ever before, and was made up largely of pigs, chickens, pigeons, and rabbits belonging to members of the boys' and girls' clubs.

School and home garden work.—School and home gardens were visited many times during the year by the extension agent, and advice was given concerning the adaptability of various crops to the different localities and the best methods of cultivating the crops. The young gardeners were also assisted in obtaining seed and in marketing their products.

Assistance in boy scout activities.—The extension agent acted as scout commissioner for the island of Hawaii and as examiner for members desiring to qualify for agricultural merit badges. Examinations were held in agriculture, beekeeping, conservation, dairying, forestry, gardening, and poultry keeping.

Distribution of literature.—United States Department of Agriculture Farmers' Bulletins and circulars were distributed to boy scout troops at the posts for use in their libraries and as guides in preparing for examination for merit badges.

Extension of culture of the edible canna.—The potential possibilities of the edible canna for starch-manufacturing purposes and the adaptability of the crop to the Waimea district were deemed sufficient reasons for making experiments with the crop in that district. Waimea (2,600 feet elevation) is a wide, level valley between the Kohala Mountains and Mauna Kea. The rainfall of the district is plentiful and evenly distributed throughout the year, and the soil is such that where corn and potatoes can not be profitably grown edible canna can be produced. The ill effects of strong winds, which apparently are the only serious drawback to canna production in the region, can be practically overcome by growing windbreaks. Edible canna can be grown at elevations which are too high for sugar cane and pineapples, and on lands that are considered unadapted to anything but grazing. In view of the increasing demand for larger areas for edible canna production and the possibility of utilizing some of the thousands of acres of land which is now devoted to grazing in the Kohala, Kona, and Hamakua districts, it was decided to start experiments at different elevations to learn the adaptability of edible canna to various climatic and soil conditions. The crop is being grown for 15-month periods in selected plats throughout the island. Part of each crop is to be harvested at intervals, beginning with the eighth month after planting, and records are to be kept of the growth and yields made. A rain gauge has been placed in each plat to show the amount and distribution of the rainfall.

The frequent though light rains of the Waimea district cause a luxuriant growth of weeds, which check the growth of edible canna unless horse cultivation and hand weeding are resorted to during the first five months after planting. This is an expensive process, and might well be dispensed with in favor of the use of arsenite of soda, which has proved a most efficient weed destroyer in cane fields. Fields receiving no horse cultivation, with little or no hand hoeing of the ratoon crop, gave consistently higher yields than did adjoining fields which were cultivated in the usual manner. An experiment was therefore undertaken in cooperation with the chemical division of the station to determine the relative yields and cost of cultivating two adjoining acres, using a poison spray on one and cultivation and the hoe on the other.

Extension of planting of fruit trees.—Seedling avocado and citrus trees were budded both at the nursery for distribution and on homesteads in different parts of the island. Special attention was given to establishing a sufficient number of avocado trees of different varieties which will bear during the winter months, so that the fruit may be available throughout the year

Extension of the use of the pigeon pea.—During the summer pigeon peas were planted in the school gardens to keep down weed growth and enrich the soil, and seed of the crop was distributed to all schools requesting it. A field of 100 acres at the Kapapala ranch in Kau was planted with pigeon peas and divided into paddocks to allow the crop to recover after having been heavily grazed. This plan is followed with great success on Maui, and should be more widely adopted than it is on Hawaii.

Grass demonstration and distribution work.—The experimental work with range grasses and forage crops carried on in cooperation with the Parker ranch in 1921 and 1922 was maintained, and areas in the Waimea and similar districts, where 12 of the varieties grew well and proved adapted to local conditions, were enlarged. Seeds, cuttings, and roots were planted in other sections of the ranch and also distributed to ranchmen, homesteaders, and dairymen throughout the island. One demonstration plat was maintained at the Konawaena School, in Kona, and another at Laupahoehoe, in Hamakua.

Planting windbreaks.—An effort was made to induce homesteaders to plant trees for windbreaks in parts of the island where crops are likely to be damaged by strong winds. The extension agent assisted the local nursery of the Board of Agriculture and Forestry to distribute seedling trees to homesteaders living in the more remote parts of the island.

BOYS' AND GIRLS' CLUB WORK

By Mabel Greene

Vacation clubs.—Six school centers conducted 12 4-H clubs in gardening, sewing, and handicraft during eight weeks of the summer vacation period, June 13 to August 14, and separate records were kept of the work done. The work was directed by 12 teachers, a man and a woman who are specialists in vocational training and whose salaries were paid by the recreational committee of the board of supervisors being chosen for each center. Ruth C. Hoffman, primary supervisor of the Honolulu public schools, cooperated with the club leader in supervising the centers. The articles made by club members were placed on exhibition for sale in August and in November. Fifty per cent of the proceeds was given to members making the articles, and the rest was used to cover the cost of material and of plowing the ground for the gardens. The vacation clubs were successful from both an educational and a financial standpoint, and the work done by the members was complimented and indorsed by the board of directors of the Honolulu Chamber of Commerce.

Standard clubs.—The 81 standard clubs of the islands are distributed as follows:

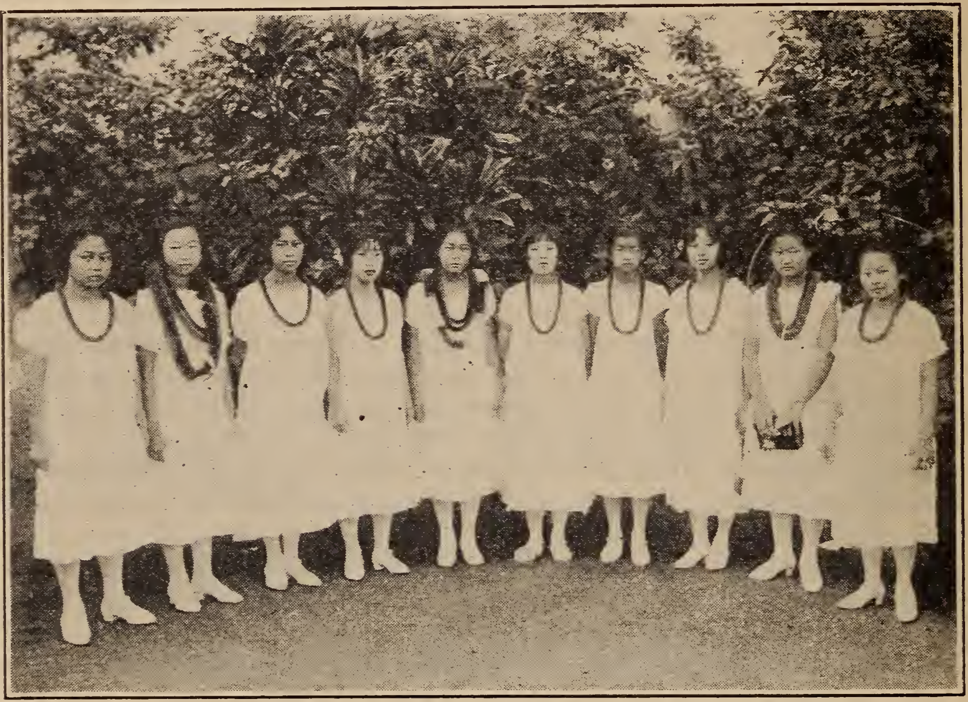

FIG. 8.—4-H Sewing Club, showing graduation dresses made by members of the club

TABLE 2.—*Distribution of boys' and girls' clubs in Hawaii*

Club	Distribution				
	Oahu	Maui	Hawaii	Kauai	Total
Canning	2	2	1		5
Cane (sugar)			2		2
Flower			1		1
Garden	12	1	4	1	18
Poultry	4		8		12
Pig		2	3		5
Cooking	2		4		6
Bread making	2				2
Clothing	16	1	7		24
Rabbit			6		6

A number of local exhibitions were held in connection with the achievement day program. Interesting demonstrations were given in seed-corn testing by the Territorial Normal School, removing stains from clothing by the Needles and Pins Sewing Club, and a style show was conducted in which 24 girls wore self-made dresses for exhibition.

Club activities were carried on in cooperation with the Parent-Teachers' Association, the club division of the Young Women's Christian Association, the extension division of the station, and the Practical Arts' Club, which is composed of vocational teachers. Some extension work was done with a group of mothers of the Kakaako district of Honolulu through the Daughters of Hawaii Club and the club group of the Young Women's Christian Association.

Agricultural lantern slides were shown at various gatherings, and club songs and club yells were used as a means of keeping the young people interested in their work. Achievement pins were awarded where the making of graduation dresses formed a part of the clothing club work of the school. (Fig. 8.)

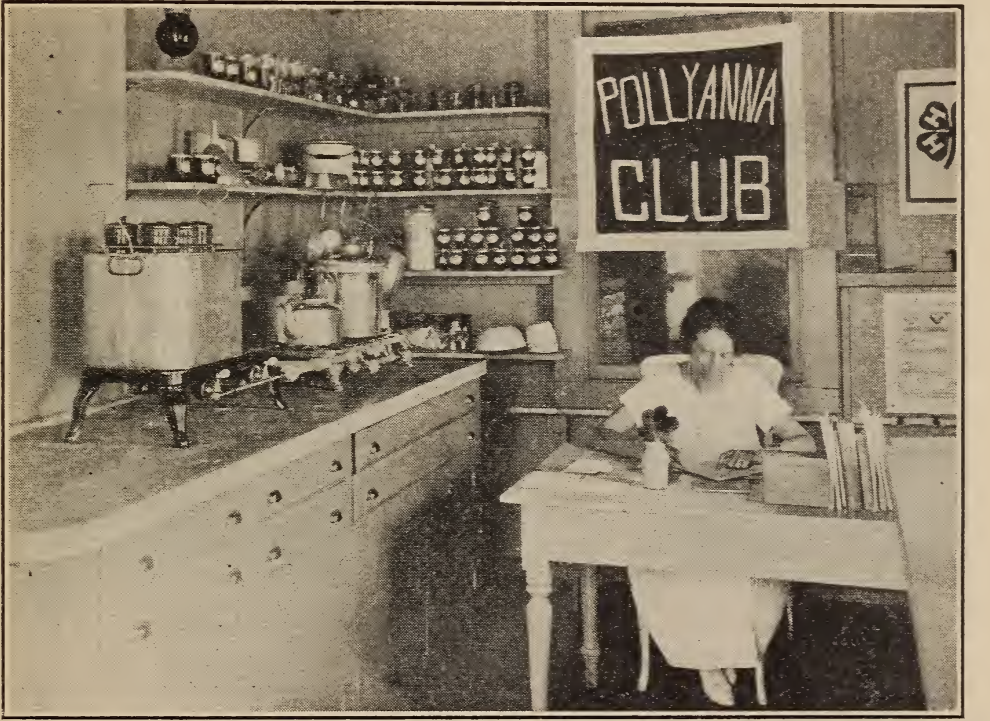

FIG. 9.—Laboratory equipment, Pollyanna Canning Club

Club sales were made by the Pollyanna Club, and the canning clubs of Waimanalo, Oahu, and Lahaina and Haiku, Maui.

Fairs and demonstrations.—Three girls from the Pollyanna Club publicly demonstrated proper methods of canning fruits and vegetables during each of three days at the Territorial Fair in October (fig.9), and creditable exhibits were entered by the canning clubs of Haiku, Maui, and Honolulu, Oahu. The Territorial garden clubs were allowed a space 350 feet long and 90 feet wide on which to exhibit their work at the fair grounds. The area was divided into 34 plats, each 18 by 20 feet in extent. (Fig. 10.) Club members confined their efforts to growing one crop, such as the sweet potato, peanut, eggplant, carrot, or taro, since single crops can be more readily marketed than small lots of miscellaneous vegetables. The club member producing the best crop was awarded a medal and a ribbon. Six schools, each entering four boys, participated in the school-garden contest held on part of the fair grounds, and members having the best gardens were awarded silver cups and ribbons. Demonstrations were given in spraying, proper methods of removing nut grass, using the hand cultivator, and preparing and applying fertilizers.

Segeichi Matsumoto, a member of the pig club of Laupahoehoe, Hawaii, was awarded an educational trip to the Territorial Fair for doing the best pig-club work in Hawaii, and the Maui Chamber of Commerce arranged to send five boys and girls from Maui to the fair, August 31 to September 9, 1925. The Haleakala and Haiku pig clubs entered 15 exhibits at the Maui County Agricultural Fair in October. Cash prizes and four pigs, given by the Maui Swine Breeders' Association, were awarded winning members. The Haiku canning club demonstrated proper methods of canning at the fair.

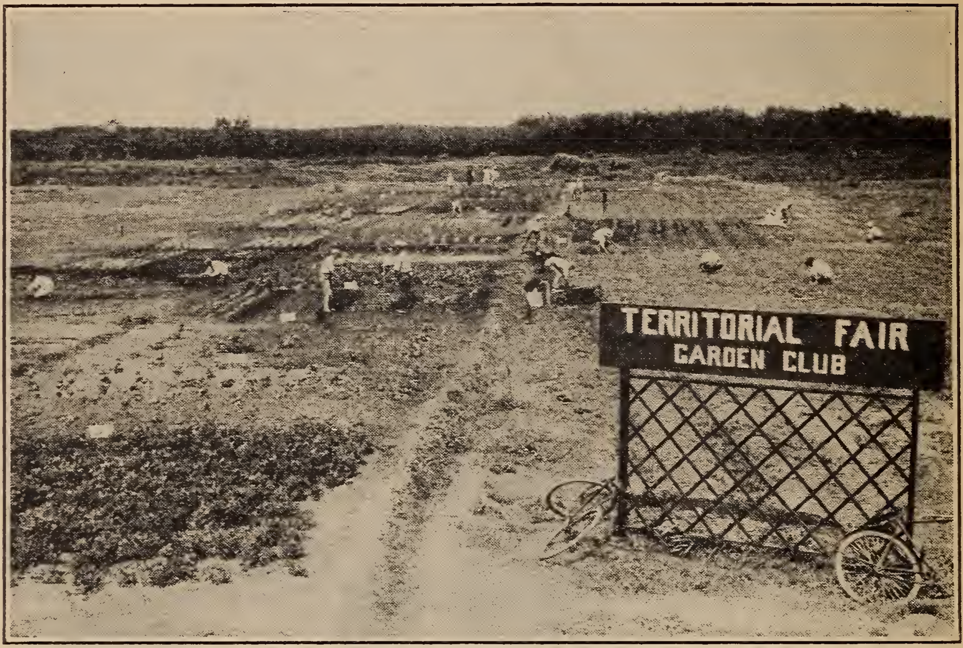

FIG. 10.—Boys' garden club plats at the Territorial Fair, Honolulu

Excellent exhibits were entered by the clubs in the Hawaii school fair, held at Hilo in May. Among them were purebred poultry and rabbits, and two young pigs which were raised from a litter by a club boy doing second-year work. Interesting and educational work was done in connection with swine, poultry, corn, rabbit, and potato judging contests, and winners of the best products were awarded cash prizes by the Agricultural Club of Hawaii, and ribbons and certificates by the fair association. The first 4-H club exhibit in Kauai was made in May by the Boys' Home Garden Club of Kapaa. This is a 100 per cent club, since every member reported.

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